U.S. DEPARTMENT OF INTERIOR
U.S. GEOLOGICAL SURVEY

PRELIMINARY GEOLOGIC MAP OF THE PAHROC SUMMIT PASS QUADRANGLE AND PART OF THE HIKO SE QUADRANGLE, LINCOLN COUNTY, NEVADA

By

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey standards and stratigraphic nomenclature

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DESCRIPTION OF MAP UNITS

[Ages of surficial deposits have not been determined by absolute dating techniques; ages are estimates based on field observations of degree of soil development and local surface dissection. The stage of carbonate development reported for soils is a visual estimate based on standards defined by Gile and others (1966). Colors of map units are from the Rock-Color Chart (Rock-color Chart Committee, 1951). Where a veneer of a younger unit masks but does not completely conceal the underlying unit, fractional symbols are used (Qal/Qae). Identification of ash-flow tuff units is based in part on the volume percent of phenocrysts as determined by thin section modal analysis and in part by thin section and hand specimen estimates of phenocryst modes. Isotopic dates are reported with 2 sigma errors, and pre-1976 K-Ar dates and ages have been recalculated to new constants of Steiger and Jager (1977) using the conversion tables of Dalrymple (1979). Previous mapping in the area has been published at a scale of 1:250,000 (Tschanz and Pampeyan, 1970; Ekren and others, 1977). Volcanic rock names are based on the chemical classifications of Le Maitre (1989) and Macdonald (1975).]

Qal **Alluvium (late Holocene)**--Grayish-orange to pale-yellowish-brown sand, gravelly sand, and minor amounts of gravel, unconsolidated, poorly to moderately well sorted, massive to moderately well bedded, locally silty. Sand is fine to very coarse near the mountain front, generally fine to medium near distal edges of large fan. Gravelly sand includes angular to subrounded pebbles and small cobbles of ash-flow tuff, lava, and locally very sparse quartzite; large cobbles and boulders as much as 1 m in diameter locally present near bedrock exposures and along some of the larger washes. Unit forms channel deposits of modern washes, steep fans flanking bedrock hills, and poorly defined fans that are inset into and overlie older fans. Channel deposits consist of interbedded sand and gravelly sand with local beds and lenses of poorly sorted gravel. Fans flanking bedrock hills typically consist of 1-2 m of silty sand and minor gravelly sand that overlie relatively undissected deposits of alluvium of Willow Spring (Qaw) that have been eroded down to the upper part of the soil carbonate horizon. Deposits bordering the large south-flowing wash near the east edge of the mapped area consist chiefly of massive moderately compact silty fine sand. Most exposures show no soil development; locally a thin sandy vesicular A horizon is developed. Maximum exposed thickness is about 2 m

Qd **Sand dunes (late? Holocene)**--Grayish-orange sand, unconsolidated, moderately well sorted; no bedding observed, calcareous. Sand is fine to coarse, chiefly medium, angular to subrounded. Forms low linear vegetation-stabilized ridges east and west of larger south-draining washes and north of most east-draining washes. Dunes are commonly covered with a thin lag of coarse sand suggesting they are undergoing eolian erosion. Dunes commonly overlie unit Qae. Soil limited to a locally developed 2-cm-thick silty sand vesicular A horizon. Thickness 0-5 m

Qae **Alluvium (early Holocene and late Pleistocene)**--Pale-grayish-brown to brownish-gray sand, gravelly sand, and minor amounts of gravel, unconsolidated to weakly consolidated, poorly to moderately well sorted, poorly bedded. Sand is fine to coarse, mostly angular, commonly silty. Clasts in gravelly sand and gravel consist of angular to subrounded pebbles and cobbles of ash-flow tuff and lava with scattered boulders commonly less than 1 m in diameter. Unit forms extensive fan remnants inset into or overlying fans of alluvium of Willow Spring (Qaw). Fan remnants consist mostly of interbedded sand and gravelly sand; gravel commonly occurs only in steep fans adjacent to bedrock exposures. Deposits of unit stand 1-2 m above channels of active washes. Surface of deposit is typically smooth and undisected. Soil development consists of a thin sandy vesicular A horizon, a 0.6- to 0.8-m-thick B horizon, and a 0.1- to 0.3-m-thick Cca horizon that has stage I carbonate development. No color change with respsect to the parent material was observed in the B horizon; the Cca horizon is weakly developed or absent where the soil is developed in sand. Thickness of unit 0 to more than 3 m

Qaj **Alluvium of Jumbo Wash (middle Pleistocene)**--Unit named for deposits along and near Jumbo Wash in the Gregerson Basin quadrangle about 15 km to the southeast (Scott and others, 1990). Yellowish-brown to grayish-orange sand and gravelly sand; weakly consolidated, poorly sorted, poorly bedded. Clasts in gravelly sand consist of angular to subrounded pebbles, cobbles, and small boulders of ash-flow tuff and lava. Unit forms small, poorly exposed terrace and fan remnants along the unnamed wash near the south border of the mapped area. Unit stands about 3 m above channels of active washes; surface is slightly dissected. No soil was exposed within the mapped area. In the Delamar NW quadrangle adjacent to the south, the soil developed in map unit typically consists of a 3- to 5-cm-thick sandy vesicular A horizon, a 30-cm-thick dark-yellowish-orange B horizon, and a 0.5- to 0.7-m-thick Cca horizon that has stage II carbonate development in the upper part (Swadley and Scott, 1990). Thickness 0 to more than 3 m

Qaw **Alluvium of Willow Spring (middle Pleistocene)**--Unit named for deposits near Willow Spring in the Delamar 3 SE quadrangle, 50 km to the south-southeast (Swadley and others, 1990). Grayish-brown to yellowish-orange gravelly sand, sand, and minor amounts of gravel, weakly to moderately well consolidated, poorly to moderately well sorted, poorly to well bedded. Sandy gravel consists of angular to subrounded pebbles, cobbles, and small boulders of ash-flow tuff, lava, and minor amounts of limestone in a poorly sorted sand matrix. Sand is fine to coarse, locally silty. Gravel is angular to rounded clasts of ash-flow tuff and lava as much as 1.5 m in diameter, has a poorly sorted sand matrix, and occurs chiefly adjacent to bedrock exposures. Unit forms numerous poorly exposed, moderately dissected fan remnants over much of the mapped area; surface of unit commonly eroded down to the pedogenic carbonate horizon. Unit stands 2-5 m above the channels of larger through-flowing washes; in the central and northern parts of the mapped area, fan remnants stand only about a meter above Holocene alluvial deposits and locally are partly buried by these younger units. Typical exposures of these fan remnants consist of a sandy surface partly covered with a pebble-cobble lag gravel and common to abundant pedogenic carbonate chips. Soil developed in map unit consists of a silty sand vesicular A horizon, a 30- to 40-cm-thick yellowish-orange B horizon that is sparsely preserved, and a 0.6- to 1.0-m-thick Cca horizon that typically has stage III carbonate development in the upper part. Thickness 0 to more than 7 m

Qc **Colluvium (Holocene and Pleistocene)**--Unconsolidated to consolidated talus; angular pebble-to boulder-sized clasts, and minor amounts of silt and sand. Unit is generally nonbedded and locally cemented by secondary carbonate. Unit occurs along base of steep slopes where it forms talus cones and along more gentle slopes where the margins of bedrock are commonly covered by a thin veneer of colluvium. Thickness of unit undetermined

QTls **Landslide debris and gravity-slide block complex (Quaternary to Pliocene?)**--Complex mixture of unconsolidated debris and coherent blocks of volcanic rocks. Crude stratigraphic order exists within slide debris. Debris is locally cemented by secondary carbonate. Unit is locally about 50 m thick. (Areas underlain by slide block debris of a single bedrock unit are designated by that bedrock symbol; areas underlain by a mixture of lithologies are designated QTls; in either case, unit is shown by coarse stipple pattern and, where appropriate, by fault trace with open teeth on the slide body)

QTa **Alluvium (early Pleistocene and Pliocene?)**--Grayish-brown to brownish-gray gravel and gravelly sand, moderately well consolidated, poorly sorted, and poorly bedded. Consists of angular to rounded pebbles, cobbles, and boulders as much as 2 m across of ash-flow tuff, lava, and limestone in a sand and fine gravel matrix. Unit forms poorly exposed eroded fan remnants that crop out as rounded ridges littered with a lag of boulders and common to abundant chips and plates of pedogenic carbonate; occurs near the north-central border of the mapped area. Soil removed by erosion. Maximum exposed thickness about 10 m

Tsc **Scarp colluvium (Miocene?)**--Brownish-gray debris, moderately well consolidated, very poorly sorted, poorly bedded to nonbedded. Debris consists chiefly of subangular to rounded boulders of Hiko Tuff in a fine pebble to sand size matrix from the same source; boulders as much as 2 m across are common, some as large as 5 m. Rounding of boulders has occurred primarily during in-place weathering, not by fluvial transport. Unit occurs along the range-front fault scarp at the east edge of the South Pahroc Range; largely poorly exposed. No soil exposure observed. Thickness more than 40 m

Ta **Alluvium (Miocene)**--Light-brownish-gray to brownish-gray alluvium consisting of monolithologic boulders in a matrix of finer debris. Clasts consist of Hiko Tuff (Th). An isolated exposure occurs 0.4 km south of the northern boundary and 4.2 km west of the eastern boundary of this quadrangle. More extensive exposures of map unit occur in the Pahroc Spring quadrangle to the north where the unit is called the alluvium of Hiko Tuff boulders; there the unit is interpreted to be a remnant of an alluvial fan that developed on the downdropped block of the south-dipping Pahroc Valley fault (Scott and others, 1992). Thickness is at least several meters in mapped area but is at least 25 m thick in the Pahroc Spring quadrangle to the north

Kane Wash Tuff (Miocene)--Mildly peralkaline and metaluminous to trachytic ash-flow tuff sequence consisting only in mapped area of the mildly peralkaline, younger Gregerson Basin Member that includes two cooling units. The metaluminous, older Grapevine Spring Member pinches out in the Delamar NW quadrangle to the south (Swadley and Scott, 1990)

Tkb **Gregerson Basin Member**--Mildly peralkaline rhyolite (comendite) (Novak, 1984; Novak and Mahood, 1986; and unpublished data) ash-flow tuff consisting of at least two nearly identical cooling units. Defined as equivalent to members V_2 and V_3 of the Kane Wash Tuff of Novak (1984) by Scott, Swadley and Novak (in press). The cooling units are not mapped separately in all localities because lithologic similarities make them indistinguishable and the cooling breaks are not traceable. Where cooling breaks are traceable, they are shown as the upper cooling unit (Tkbu) and the lower cooling unit (Tkbl), both described below. Trachytic caps found closer to the Kane Springs Wash caldera, located about 27 km to the southeast, are not present in mapped area. Massive comenditic middle zones and basal zones found closer to the source form the unit in this quadrangle. Middle zones are devitrified, moderately to densely welded, and yellowish gray to light brownish gray. Middle zones contain about 5-10 % highly flattened pumice fragments. No lithophysal cavities are present in contrast to exposures of these zones closer to the Kane Springs Wash caldera, the source of the Kane Wash Tuff. Middle zones contain about 25 % phenocrysts that consist of about 30 % quartz, 65 percent sanidine, 1 % altered hedenbergite, and 1 % altered fayalitic olivine, 2 % ilmenite, and accessory zircon and perrerite or chevkinite. A trace of lithic fragments and scarse xenocrysts of plagioclase and biotite are present. The middle zones are each about 25-30 m thick. Basal zones in their upper part are partly devitrified, densely welded, commonly mottled pale blue, medium bluish gray, grayish green or pale yellowish brown. Basal zones in their upper part contain about 5 % phenocrysts that consist of 20 % quartz, 70 % sanidine, 5 % hedenbergite, 3 % fayalite, 2 % ilmenite, and accessory zircon, acmite, and perrierite or chevkinite. Partings parallel to the plane of compaction follow boundaries between 2- to 8-cm-thick layers of tuff that differ in phenocryst abundances; these layers probably represent welded ash-fall tuff. Upper part of basal zones contain about 0.5 percent lithic fragments and sparse xenocrysts of plagioclase, biotite, and hornblende. Basal zones in their lower part are commonly nonwelded to partially welded, moderate orange pink to pale yellowish orange, and contain slightly fewer phenocrysts than middle zones. Basal zones are about 10 m thick each. The K-Ar sanidine date for the lower cooling unit of the Gregerson Basin Member is 14.1 ± 0.4 Ma (Novak, 1984), and the $^{40}Ar/^{39}Ar$ sanidine dates for the upper and lower cooling units of the Gregerson Basin Member are 14.39 ± 0.28 and 14.55 ± 0.14 Ma, respectively (L.W. Snee, written commun., U.S. Geological Survey, 1991). Exposures of unit form gentle slopes near the central part of the mapped area. The two Gregerson Basin Member cooling units combined are at least 75 m thick

Tkbu **Upper cooling unit**--Peralkaline comenditic rhyolite ash-flow tuff, as described above. Unit mapped separately only in west-central part of mapped area. Thickness at least 45 m

Tkbl **Lower cooling unit**--Peralkaline comenditic rhyolite ash-flow tuff, as described above. Unit mapped separately only in west-central part of mapped area. Thickness at least 30 m

Ts **Sedimentary tuff**--Light-gray to yellowish-gray bedded ash-fall(?) and reworked tuff containing subordinate layers of light-greenish-gray nonwelded ash-flow tuff. Ash-flow tuff contains sparse phenocrysts of quartz and sanidine and abundant zeolitized pumice fragments. Unit is exposed only in southeastern part of area of bedrock exposure and stratigraphically occurs between Gregerson Basin unit (Tkb) and the orange cooling unit of the Delamar Lake unit (Tkdo) of the Kane Wash Tuff. Unit thickness is about 10 m

Delamar Lake Tuff--Rhyolitic ash-flow tuff consisting of three cooling units (Scott, Swadley, and Novak, in press). The Delamar Lake Tuff is equivalent to member O of Novak (1984) and has a K-Ar sanidine date of 15.6±0.4 Ma (Novak, 1984). No unfaulted section of the unit exists and unit thickness is estimated to be about 100 m in the southern part of the mapped area and less in the northern part

Tdlo **Orange cooling unit**--Simple cooling unit consisting primarily of moderate-orange, moderately welded, devitrified upper part grading downward to a dark-reddish-brown, moderately welded, vitrophyric lower part. Locally the vitrophyre is blackish red. Pumice fiamme range from 0.2 to 2 cm in length and form about 10 % of the tuff. Rock contains about 15 % phenocrysts that consist of 25 % quartz, 70 % sanidine, and 5 % fayalitic olivine and titano-magnetite. Sparse lithophysal cavities and less than 5 % lithic fragments are present. Cooling unit forms small ridges in tilted fault blocks, and thickness ranges from 0 in the south part to as much as 65 m in the north part of the mapped area

Tdlc **Crystal-rich cooling unit**--Compound cooling unit containing multiple layers of alternating moderately welded and moderately to densely welded ash-flow tuff. Most of the unit is devitrified and grayish orange pink, pale red purple, to light brownish gray. Sparse vitrophyre near the base of cooling unit has a dark-gray matrix with light-brownish-gray pumice fiamme. Pumice fiamme range from 0.1 to 5 cm long and form 25 % of the rock. Tuff contains about 25 % phenocrysts that consist of about 20 % quartz, 75 % sanidine, and 5 % fayalitic olivine and other mafic minerals. The tuff contains about 5 % volcanic lithic fragments. Unit includes 1-4 m of nonwelded to partially welded tuff near the base of the unit. Map unit forms bold cliffs and is as thick as 60 m in the southern part of the mapped area

Tdll **Lower cooling unit**--Simple cooling unit consisting of nonwelded to moderately welded, light-browish-gray to pale-red, devitrified ash-flow tuff. Pumice fiamne form 15 % of the rock, are distinctive grayish red purple, and are 0.1 to 2 cm long. Tuff contains about 15 % phenocrysts that consist of about 35 % quartz, 60 % sanidine, and 5 % fayalitic olivine and other mafic minerals. The nonwelded base of the lowest cooling unit forms an erosional bench between the overlying crystal-rich cooling unit (Tdlc) and the underlying Hiko Tuff (Th). Map unit ranges from 0 in the northwest part to as much as 60 m thick in the southern part of the mapped area

Tss **Sandstone (Miocene)**--Fluvial and ash-fall tuff, containing mostly sand-sized clasts, but including some boulder sized fragments of the Hiko Tuff (Th) in the upper part. The upper part of the unit contains fluvial structures, but the lower part consists of an ash-fall tuff containing slightly graded bedding. The upper part is very pale orange to pinkish orange, and the lower part is grayish orange pink. Unit is about 25 m thick in the northern part of the mapped area

Tb **Basalt flows (Miocene)**--Dark-gray to grayish-balck olivine-plagiocalse-clinopyroxene-bearing basalt flows. Basalt is locally vesicular near top of flows. Unit contains about 15 % penocrysts. Unit forms a resistant cap above an angular unconformity. Whole rock K-Ar date of basalt is 18.1±0.9 Ma (H.H. Mehnert, written commun., 1993). note that a solitary exposure of this basalts exists along ridge crest in northeast part of mapped area and overlies an angular unconformity above the Hiko Tuff (Th). In the Pahroc Spring quadrangle to the north, this basalt overlies an alluvial fan deposit containing clasts of Hiko Tuff south of the Pahroc Valley fault, a strand of the Timpahute lineament (Scott and others, 1992). Map unit is at least 10 m thick

Th **Hiko Tuff (Miocene)**--Rhyolitic ash-flow tuff, consisting of one compound cooling unit. Tuff is devitrified, is moderately to densely welded, and has a eutaxitic texture. Rock is mottled very light gray to light gray; lenticular pumice fragments are a lighter shade of gray than the matrix, range from 0.3 to 8 cm in diameter along the plane of foliation, and form 20 % of the rock. Lithophysae are commonly 4 cm in diameter and form between 2 and 10 % of the rock. Tuff contains about 40 % phenocrysts that consist of 20 % very pale purple quartz, 15 % sanidine, 50 % plagioclase, 10 % biotite, 4 % hornblende, 2 % Fe-Ti oxides, and accessory zircon, apatite, sphene, and allanite. Tuff contains trace to 4 % lithic fragments consisting largely of argillite. Toward the lower part of the unit a vitrophyre is generally present; the vitrophyre is mottled medium gray to grayish black; lenticular pumice fragments are a darker shade of gray than the matrix, range from 0.3 to 6 cm in diameter along the plane of foliation, and form 25 % of the rock. Commonly the lowest part of the unit is partially welded to nonwelded. At some localities this less welded part of the Hiko Tuff is included in the map unit; a separate description of this lower part of the Hiko Tuff is given below for localities where the less welded part is mapped as a separate unit. At one locality in the central-southern part of the map area, the sequence includes the presence of a partially welded zone sandwiched between overlying and underlying more densely welded zones without evidence of a complete cooling break; this relationship is found in compound cooling units. In the southwestern part of the Delamar NW quadrangle, immediately south of this map area, Hudson and others (in press) have found evidence of a complete cooling break within the Hiko Tuff sequence; in contrast, no evidence exists for a complete cooling break in this map area. The $^{40}Ar/^{39}Ar$ biotite date for the Hiko Tuff is 18.5 $\pm$0.4 Ma according to Taylor and others (1989), but they suggest that the best estimate of its age may be 18.6 Ma based on additional data. Unit forms bold cliffs and is as much as 240 m thick

Thp **Partially welded zone**--Vitric to devitrified, partially welded to nonwelded ash-flow tuff; unit is subdivided from the Hiko Tuff (Th) throughout most of the map area. The tuff is very light gray; pumice is white. Unit has slightly fewer phenocrysts and slightly more lithic fragments and fewer phenocrysts that the Hiko Tuff described above, otherwise similar to Hiko Tuff (Th). Toward the base of map unit, some bedded tuffs of ash-fall origin exist. Unit forms gentle slopes and is as much as 145 m thick in the southern part of the map area but is commonly about 10 m thick in the western part of the mapped area

Tbt **Bedded tuff (Miocene)**--Grayish-orange-pink tuff, containing 10 % lithic fragments of volcanic rock. Slight bedding of undetermined origin. Map unit about 10 m thick in exposures in northwest part of mapped area.

Rhyolitic flows and tuffs of Delamar Valley (Miocene)--Rhyolite lava flow (Miocene)-- At least six major types of rhyolitic lava flows and tuffs from a silicic volcanic complex of domes and enveloping tuffs exist below the Hiko Tuff (Th) and above the Pahranagat Formation (Tp). The whole rock K-Ar date for nonhyrdrated obsidian nodules in a perlitic rhyolitic flow flows is 18.6 $\pm$0.7 Ma (H.H. Mehnert, written commun., 1993). Although exposures do not allow direct measurement of the thickness of these units, thickness of these flows (about 65 m) above the highest level of the youngest cooling unit of the Delamar Lake Tuff where it pinches out against the flows, and the local absence of the Harmony Hills (Thh), the Hiko (Th), the Delamar Lake Tuffs, and other minor units, suggest that the maximum thickness of the rhyolitic flows and tuffs of Delamar Valley as measured from its inferred base to the erosional upper surface may locally be as great as 750 m

Taft **Aphyric ash-fall tuff**--Bedded tuff, consisting of a grayish-orange-pink matrix containing very pale orange pumice fragments and medium-gray perlitic and black obsidian lithic fragments; these lithic fragments appear to be cognate and to have the same lithology as aphyric rhyolitic flow (Tar). Bedding typically is 5-20 cm thick and is displayed by graded bedding formed by differences in the abundances of pumice and lithic fragments; pumice fragments form 5-90 % of the rock and are typically about 0.3-2 cm long. Lithic fragments are generally less than 1 cm in diameter and form less than 15 % of the rock. Locally, sparse lithic fragments greater than about 20 cm in diameter have deformed underlying layers by impact; these fragments are draped by ash-fall debris. These depositional relationships suggest a local source. Unit is exposed on east-facing cliffs of the South Pahroc Range, where it is occurs above and below exposures of aphyric rhyolitic flow (Tar). Unit is as great as about 120-150 m thick south of the pinch-out of the aphyric rhyolitic flow (Tar), but aphyric ash-fall tuff itself pinches out to the north against a thickening wedge of the aphyric rhyolitic flow (Tar)

Tar **Aphyric rhyolitic flow**--In part devitrified and flow banded and in part perlitic where flow contains nonhydrated obsidian remnants (Apache tears). Flow banding in the devitrified part is contorted, ranges from 1 to 5 mm thick, and is defined by alternating thinner pinkish-gray layers and thicker light-brownish-gray layers. Perlitic part is also flow banded but this feature can be observed readily only on weathered surfaces. Most of the perlite contains sparse to common obsidian remnants that are generally 1-3 cm in diameter. Some exposures of massive perlite have been prospected and two adits have been mined. Unit is exposed in the northern part of the east-facing cliff of the South Pahroc Range, pinches out toward the south into aphyric ash-fall tuff (Taft), and is at least 180-200 m thick

Trf **Rhyolitic flow**--Mottled light-gray to medium-gray, indistinctly flow banded, quartz- and sanidine-phyric flow. Contains less than 10 % phenocrysts and quartz is more abundant than sanidine. Unit form a steep erosional remnant of a lava dome in the western side of the mapped area that was at least 100 m high

Eastern complex of rhyolitic lava domes, lava flows, and minor ash-fall tuff--Within the rhyolitic flows and tuffs of Delamar Valley, a distinct complex of lava domes and flows occurs in the eastern mapped area. This complex includes vitric frothy and vitric denser flows and domes (vitropyric flows, Tvf) that partly encapsulate devitrified interiors of flows and domes (devitrified flows, Tdf). This complex also extends southward into the adjoining Delamar NW quadrangle (Swadley and Scott, 1990) where the map unit clearly underlies the Hiko Tuff. Phenocryst assemblages in this complex include chiefly sanidine, quartz, plagioclase, and biotite, and the abundance of phenocrysts ranges between 10 and 35 % of the rock. The complex forms elongate landforms, aligned domes, and flow foliations that trend parallel to valley axes and major faults

Tvf **Vitrophyric flows**--Frothy to dense massive vitrophyric flows. Frothy flows are lighter colored, generally pinkish gray to yellowish gray; denser, less porous vitrophyres are darker and range from grayish black to moderate red. Dense vitrophyres are locally perlitic. Only remnants of the vitric envelope around flows are preserved and the vitrophyric parts of flows are tens of meters thick

Tdf **Devitrified flows**--Light-brownish-gray to brownish-gray, massive rhyolitic interiors of flows. Flow banding is indistinct to absent. About 75 m of devitrified flows are exposed

Tnt **Nonwelded tuff**--Grayish-orange-pink ash-fall or ash-flow tuff underlying some of the flows at one locality 3.4 km west of the eastern boundary and 4.6 km north of the southern boundary of the mapped area. Unit contains the same phenocryst mineralogy, pumice fragments, and lithic fragments as the rest of the complex. About 12 m of the unit exposed

Thh **Harmony Hills Tuff (Miocene)**--Andesitic ash-flow tuff, consisting of one simple cooling unit grading downward from a partially welded upper zone, to a moderately to densely welded central zone, and to a nonwelded basal zone. Unit is devitrified, phenocryst-rich, and massive with an indistinct foliation. The central zone of the unit ranges between pale red where more weathered and light olive gray to pinkish gray where fresher rock is exposed. Pumice fragments are sparse. The rock contains about 50 % phenocrysts that consist of 2 % quartz, less than 1 % sanidine, 65 % plagioclase, 20 % biotite, 7 % hornblende, and 2 % clinopyroxene, 1 % orthopyroxene, 4 % opaque phases, and accessory zircon, apatite, sphene, allanite, and perrierite and/or chevkinite. Lithic fragments form only a trace of the rock. Unit forms cliffs, the lower parts of which are commonly covered with colluvial debris derived from the unit itself and the Hiko Tuff (Th). A small bench marks the top of the unit. Five K-Ar dates by Armstrong (1970) and one by Noble and McKee (1972) average 21.6 Ma for the unit; however, isotopic dates of 22.5-22 Ma for plutons and an ash-flow tuff that postdate the Harmony Hills Tuff in the Iron Springs District of southwest Utah may provide a better age constraint (Rowley and others, 1989). The Harmony Hills Tuff is about 50 m thick in the exposures in the northwest part of the mapped area but is absent farther south where it probably pinches out against a series of rhyolitic flows and tuffs of Delamar Valley

Tp **Pahranagat Formation (Miocene)**--Rhyolitic ash-flow tuff, consisting of one simple cooling unit (redefined by Scott, Grommé and others, in press). The tuff is devitrified, partially welded to moderately welded, and grayish pink to grayish orange pink. Pumice fragments are 0.3-5 cm in diameter and form about 20 % of tuff. Rock contains about 15 % phenocrysts that consist of 29 % quartz, 29 % sanidine, 36 % plagioclase, 4 % biotite, 1.5 % opaque phases, and accessory zircon, apatite, sphene, and allanite. About 1 % lithic fragments occur in the tuff. The $^{40}Ar/^{39}Ar$ date for the tuff is 22.65 ± 0.02 Ma (Deino and Best, 1988). Exposures of the Pahranagat Formation are limited to the east-facing cliff of the South Pahroc Range on the western side of the mapped area

Tcb **Bauers Tuff Member of the Condor Canyon Formation (Miocene)**--Rhyolitic ash-flow tuff containing a distinctive phenocryst assemblage of sanidine, plagioclase, and biotite. The tuff is pinkish gray, devitrified, moderately welded, and relatively crystal poor in the upper part (about 10 % phenocrysts), is light brownish gray, devitrified, densely welded, and more crystal-rich in the middle part (about 20 % phenocrysts), and forms a grayish-black to brownish-gray, moderately to densely welded, relatively crystal-rich vitrophyre in the bottom part (about 20 % phenocrysts). Distinctive pinkish-gray flow partings common in the middle part are as long as 0.5 m but only a few millimeters thick; these partings are similar to highly flattened pumice fragments that are smaller in diameter (< 8 cm). The phenocrysts in the middle part of the Bauers consist of about 30 % sanidine, 55 % plagioclase, 13 % biotite, and 2 % pyroxene and accessory Fe-Ti oxides, zircon, and apatite; the absence of quartz is distinctive. The tuff contains less than a few percent lithic fragments and as much as 10 % highly flattened lithophysal cavities above the vitrophyre. The average K-Ar age of the Bauers is 22.7 Ma (Armstrong, 1970), close to the $^{40}Ar/^{39}Ar$ sanidine date of 22.78 ± 0.03 Ma (Best and others, 1989). The older Swett Tuff Member of the Condor Canyon Formation is absent. The Bauers Tuff Member forms steep slopes and minor cliffs and is about 60-80 m thick

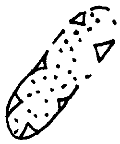
Tip **Isom-like tuff of Pahroc Valley (Miocene)**--Trachyandesitic densely welded ash-flow tuff resembling, but distinctly younger than, the Isom Formation (Anderson and Rowley, 1975). Upper part of unit consists of a devitrified, pumiceous, moderate-reddish-orange to moderate-reddish-brown, moderately welded tuff; the middle part consists of a grayish-red densely welded tuff, and the lower part consists of a blackish-red to grayish-black vitrophyre. The rock contains about 15-25 % phenocrysts of plagioclase and lesser amounts of clinopyroxene and Fe-Ti oxides, a mineralogy similar to that of the Isom Formation. The absence of biotite is diagnostic. In devitrified rock, pyroxene is commonly altered to moderate-greenish-yellow to moderate-yellow clay-like phases and the plagiclase is an opaque white. Lithic fragments form about 5 % of the rock. Unit forms steep slopes. Age of unit between that of the overlying Bauers Tuff Member (22.7 Ma) and that of the Swett Tuff Member (about 23.7 Ma based on dates from Armstrong, 1970) of the Condor Canyon Formation, which underlies the unit in the Pahroc Spring quadrangle (Scott and others, 1992), immediately north of the mapped area. Although this unit is between 5 and 10 m thick in the Pahroc Spring quadrangle to the north, also typical of thicknesses of members of the Isom Formation, this Isom-like tuff of Pahroc Valley is as much as 190 m thick along the steep east-facing slopes of the South Pahroc Range in the mapped area

Tlc **Leach Canyon Formation (Oligocene)**--Rhyolitic ash-flow tuff, partially to moderately welded, devitrified, and very light gray, pinkish gray, to yellowish gray. Abundant flattened pumice fragments form 10-20 % of the rock, are commonly light brownish gray, and are 0.3-2 cm long in the plane of foliation. The rock contains 15-25 % phenocrysts that consist of 20-60 % quartz, 10-40 % sanidine, 20-55 % plagioclase, 2-14 % biotite, traces of hornblende and pyroxene, and accessory Fe-Ti oxides, sphene, zircon, and apatite. Lithic fragments are sparse in the upper part of the unit. Only the upper part of the Leach Canyon Formation is exposed in the map area where it forms bold light-colored slopes at the base of the east-facing cliffs of the South Pahroc Range. The average of three K-Ar dates (Armstrong, 1970) and one fission track date (Kowallis and Best, 1990) indicates an age of about 24.6 Ma but with large errors; a better estimate of the age of the unit may be the average age of a coexisting sanidine and biotite pair dated by Armstrong at about 23.8 Ma. About 150 m of the Leach Canyon Formation are exposed

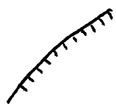
Oe **Eureka Quartzite (Middle Ordovician)**--Quartzite is white where fresh and moderate-brown to dusky-yellowish-brown where weathered. Exposures contain highly fractured rock indicative of intense deformation; only a 100-m-wide slice of the Eureka is present between two strands of the Pahroc Fault in the southwest part of the mapped area. No other Paleozoic strata are exposed in this mapped area; however, the lower Devonian Sevy Dolomite occurs in the Pahroc Spring quadrangle about 15 km to the north, and the middle and lower Ordovician Pogonip Group occurs in the Alamo NE quadrangle about 7 km to the south-southwest

Contact

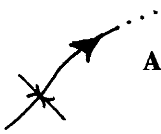
High-angle fault, showing dip (barbed arrow) and trend and plunge of lineation (diamond-shaped arrow)--Dashed where approximately located; dotted where concealed; and queried where uncertain. Bar and ball on downthrown side



Low-angle fault below landslide block--Sawteeth on upper plate of slide block. Dashed where approximately located; dotted where concealed. Coarse stipple pattern on upper plate

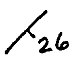


Erosional scarp along a fault against which younger unit has been deposited--Hachures on side of postfault deposit



Axis of syncline--Small arrows point in direction of dip of strata; large arrow points in direction of plunge of axis, dotted where concealed

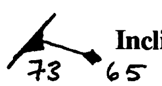
Strike and dip of sedimentary beds and compaction foliation of ash-flow tuffs



Inclined

Horizontal

Strike and dip of flow foliation



Inclined--Barbed arrow shows direction of plunge of lineation

Prospect

Adit

Artificial fill

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Correlation of Map Units